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tween a zoöid and an individual does not seem very great. Through those jelly fishes called the Trachynemidæ, as Circe, there seems to be a close relationship between the hydroid Medusa, Lizzia, and the common Aurelia, Cyanea and other Discophoræ. As therefore I cannot but designate a Pelagia, also a Discophore, as an individual, I must look upon a Circe as the same, and since Lizzia and Circe are closely related, their free Medusæ are likewise morphological individuals. If this is true, and our theory of the likeness between *Agalma* and Lizzia not fanciful, is it proper to call the members of the former colony zoöids, or shall we regard them true individuals?

The solution of this problem as to the exact nature of the members of an *Agalma* colony is most difficult, and, as so many before me, I must leave this speculative part of my subject with the trite remark, that in this animal we have a condition of life where the difference between organ and individual is reduced to a minimum. It is without doubt true that much of the controversy which has been indulged in, as to the exact nature of the different components of the *Agalma*, may reduce itself to a quarrel about terms.

THE RELATION OF APICULTURE TO SCIENCE.[1]

BY A. J. COOK.

I ONCE heard a well known professor and scientist, than whom there is no better student of American agriculture, remark, that the art of agriculture was founded almost wholly upon empiricism; and that all it had to thank science for, was that the latter explained what had already been determined by the empiric method. Whether this be true or not, the reverse is most certainly true of practical entomology. Economic entomology rests almost wholly upon science. So, too, apiculture, as practiced to-day, owes its very existence to science. Fear deters most people from bee-keeping, unless a desire to study bees, and to know more of the nature and habits of these marvels of nature, impels to that close association with bees, which practical apiculture demands.

For this reason, there is no class of men engaged in manual labor pursuits which possesses the intelligence and enthusiasm which characterize apiarists, or which practices so much that is really scientific. The successful apiarist of to-day must be able to inspect every part of his hives; must be constantly familiar with the precise condition of every colony of his bees; must be possessed of quick and accurate powers of observation. Thus we understand why science has gleaned so much from practical apiculture.

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[1] Read before the Entomological Section of the A. A. A. of S.

The nature of the several bees in each colony, as to sex, function and longevity, is now well known to every intelligent apiarist. The peculiar characteristics of queen, drones, and workers, and the peculiar duties of workers of different ages, are matters of daily observation.

The queen is seen to lay three or four eggs per minute, and the apiarist, by adding comb with empty cells, proves that she may lay as many as 4000 eggs per day. Aristotle was correct, then, in calling the queen the mother, and Virgil wrong in pronouncing her to be the king. Her hatred of rivals is easily shown by the certain combat, fatal to one of them, when two queens are placed together. This enmity induces swarming, as bees rarely suffer a plurality of queens in the same hive. In swarming the queen never leads, yet the special place of clustering is usually determined by the queen. Unless the queen accompanies the swarm, the latter will always return to the hive.

By clipping one wing of a virgin queen, so that flight will ever after be impossible, the bee-keeper quickly proves the correctness of the great Huber's discovery, that queens always mate on the wing. The same experiment proves the correctness of Dzierzon's more wonderful discovery, that drone bees are a result of agamic reproduction. No queen whose wing is clipped while yet a virgin, so far as I have observed, and I have tried the experiment many times, will ever lay eggs that will produce other than drone bees. It is also true that if a queen is forced to virginity for three or four weeks, she will always remain a virgin.

Upon the queen's return from her mating flight, we may observe the evidence of success, as she always if successful bears away a portion of the drone's reproductive organs, which remain attached to the queen for some hours.

It was a theory of the late Samuel Wagner, that the placing of unimpregnated eggs in the larger cells of the drone comb, and the impregnated ones, in the smaller worker cells, was simply automatic. The pressure from the smaller cell upon the queen's abdomen, forced the sperm cells from the spermatheca, as the eggs passed by. As there would be no such pressure from the larger drone cells, the spermatozoa would not be extruded from the spermatheca. Practical bee-keepers have shown this to be untrue.

Queens have been seen to lay eggs in the still larger queen cells, which eggs are always impregnated. The queen often lays in worker cells, where the walls are but just commenced, and where there is no compression; yet such eggs are always impregnated. That the bringing of the sperm cells into connection with the germ cells, or the withholding of them, as the eggs are to produce females or males, is a matter of volition with the queen, is sustained by the muscular character of the spermatheca. It is a curious fact, that young queens, when they first commence to lay, often put several drone eggs into worker cells, though after the first day or two, they generally deposit only impregnated eggs for the first season. It seems probable, that the muscles of the seminal sack of the queen do not act efficiently till somewhat in practice.

An anomalous physiological fact is illustrated in the flight of the queen when swarming takes place. Though she may not have used her wings since her marriage flight, possibly for two or more years, yet the muscles are by no means atrophied, as shown by her rapid flight, often for several miles, *en route* to her future home.

The reason why a few impregnated eggs develop into queens, while thousands of the same produce worker bees, appears to be wholly due to quality and quantity of food. They receive much more and much richer food. The enlarged cell is necessary to a full sized queen, but not to a queen. The exceptional position of queen cells is simply for convenience, as it is not important.

Direct observation, as also her removal from the hive, shows that the only function of the queen is to lay eggs.

I have known a queen to lay with no abatement of fertility for five years, though often in one or two years she ceases to be prolific, either from her own impotency, or from a depletion of the spermatheca, in which case only drone bees are produced. Usually the worker bees arrange to supercede the queen before she becomes an exclusive drone producer.

Common observation proves that the drones are males, that they are great eaters, and that they have no function in the economy of the hive, except the sexual function. As already explained, the drone loses a portion of his reproductive organs, in mating, which act is attended with immediate death.

Though doubt is sometimes expressed as to the origin of drones by parthenogenesis, there is no such doubt among intelligent apiarists. If the wing of the virgin queen is clipped, or the entrance to the hive so contracted that she cannot fly, or again, if she is reared when there are no drones, she will be, not sterile, but from her eggs will come only drones. Often these will be in the small cells, when the drones will be no larger than the workers. The eggs from fertile worker bees, and also from old queens, with depleted spermathecas, will likewise produce only drones. In appearance and structure these drones are every way normal. I have no doubt but that they are functionally perfect.

There is an interesting fact connected with the appearance and disappearance of drones, whose explanation seems to call for an intelligence above instinct. As the colonies become very populous in spring, the worker bees build drone comb, and rarely even tear down and replace worker with drone cells, and the queen lays the unimpregnated eggs in such cells, preparatory to rearing queens, and to swarming. If we remove a queen none but drone comb will be built. Now suppose a colony is strong and preparing to swarm, and suddenly, from lack of bloom, continuous rains or great drought, the secretion of nectar suddenly stops. Honey gathering of course ceases, brood rearing is discontinued, and, not infrequently, the bees kill all the drones, and even drag the larvæ and pupæ from the cells. As soon as the honey harvest is hopelessly cut short by the autumn frosts, the worker bees commence at once to bite and worry the drones, till the latter are driven forth to die. But if the colony be queenless, or if the queen has become superannuated, the drones will be permitted to remain in the hive all winter. The fate of the drones hangs on the prosperity of the colony. With rapid increase of bees and honey they are safe; adversity in these respects, unless caused by loss or impotency of the queen, betokens their speedy extinction.

Drones are tolerated in a strange colony, which is not generally true of either the queen or workers.

The longevity of drone bees, as we have seen, is largely dependent upon circumstances. There is good reason to believe that they may live through the entire season.

The worker bees are imperfectly developed females, which from receiving less and different food, while larvæ, are immature in their sexual development. A worker larva, less than three days from hatching, will, if given more and richer food, develop into a queen. If an apiarist allows a colony to go queenless for a long time, fertile workers are almost sure to appear, from whose eggs, however, none but drones are produced. Some apiarists suppose that such workers receive, perhaps by accident, a richer and more abundant pabulum. I have wondered if this might not verify Lamarck's idea of evolution. The bee desires eggs, and the deeply felt want induces the extra ovarian development.

The worker bees are shorter than the drones and queen, and less robust than are the drones. Their wings are small but strong, and move very rapidly in flight. When the bees are angry the rapidity is still more marked, and there is a corresponding increase of pitch to the hum.

The workers, as the name implies, do all the work of the hive, hence a reason for their better developed mandibles, with which they cut comb, remove cappings and dig pollen from the cells; their longer tongues and maxillæ, with which they extract nectar from deep tubular flowers, and the deep baskets on their posterior tibiæ and basal tarsi, which are wanting in the queen and drones, in which they carry pollen and propolis to their hives. As they protect the hives from intrusion, they need and possess a better developed sting than that of the queen, which is only used in dispatching rivals.

By the introduction of Italian bees, which differ greatly in color from the German or black bees, bee-keepers have learned that the old bees, for the most part gather the honey pollen and propolis while the young bees remain within the hive and secrete the wax, build the comb, feed the brood and cap the brood cells, though the old bees will do the work of the young ones if for any reason the natural equilibrium of the colony is destroyed.

That bees possess and use the sense of smell, is obvious to the apiarist. If he unite two colonies, they often engage in fierce combat, which only terminates when one of the parties is vanquished. By smoking, sprinkling with an essence, or otherwise giving to both the colonies the same scent previous to the union, perfect peace and harmony is secured. The same fact leads to somewhat similar precautionary measures in introducing queens.

In going to any place, bees seem to be guided by direction rather than sight. Thus if we move a hive, but for one or two feet, the bees will, for days, descend to the old position, and then turn abruptly to the hive. I have been led to notice a strange exception to this; by placing honey on a porch of one of two houses that are exactly alike, but about five rods apart, many bees were misled and swarmed about the porch on which there was no honey. The experiment was several times repeated.

Experience shows that bees will winter quite as well with pure honey or sugar syrup for food, as though they had pollen with it. They may be kept healthy at least for a time, in confinement, in summer, on a pure hydro-carbonaceous diet, and will secrete wax and make comb, with the usual activity. But pollen is a *sine qua non* to brood rearing. Probably it is also necessary for the old bees, at times of great activity. Bees also need water. Unless very active, this want seems to be met by the water of the honey; but in shipping bees they are now generally fed with candy or crystalized sugar, and unless water is added, they perish in a few days.

Nectar, as gathered from the flowers, contains much more water than does the honey. The bees leave the nectar, which is often nearly as thin as water, some time before capping, until the necessary evaporation has transpired. Bee-keepers call this the curing process. Some nectar is so thick that it is capped very soon, though frequently it remains for days, and rarely is it of such a nature that it does not thicken, and the bees refuse to cap it at all. Such nectar, usually from bark lice, etc., is unwholesome, and unfit food, even for the bees. If thin nectar is extracted, bee-keepers evaporate the moisture from it by artificial heat, as it does not preserve its quality unless rid of the superfluous water.

One of the most terrible disasters that can befall the apiarist is to become the victim of foul-brood. In this terrible disease a fungus attacks the brood, which causes it to become putrid and disgusting. It is very contagious. The disease is common in Europe, and has brought ruin and discouragement to apiarists in several of our own States. Spraying with salicylic acid has been found an efficient cure.

The enemies of bees is certainly a matter of interest to all scientists, and especially to zoölogists. Among mammals, shrews and mice are often quite destructive to bees. The king bird, *Tyrannus carolinensis*, captures worker bees, although it is partial to drones. Toads and frogs seem to lap up bees with no inconsiderable relish, and often work quite successfully to deplete the hives.

Bees have many and formidable foes among insects. In the order Hymenoptera, a species of Xylocopa, probably *X. micans*, has been observed to kill bees in North Carolina. The cow killer, *Mutilla coccinea*, destroys bees in the States from central Illinois to Texas. It has been reported several times that ants are at times a serious foe to the honey bee. It is stated that they not only worry the bees by invading the hive, but that they sometimes kill both the queen and workers.

The only lepidopterous insect which annoys American apiarists is the bee-moth, *Galleria cereana*. And even this is no dread to the intelligent apiarist. It is found that strong colonies of bees, and no other pay, and especially if Italians, will always defend themselves against this enemy. It is only weak or queenless colonies that succumb to this foe.

Among Diptera, *Bombylius mexicanus*, is reported to enter the hives, in Texas, without resistance and lays its eggs, where the prospective larvæ will be nourished and cared for, without labor on the part of the mother fly. The family Asilidæ affords the most serious dipterous pests to the apiarist. Of these there are at least three species of Asilus, two of Mallophora, two of Promachus, two of Laphria, and two of Erax, that catch and kill bees. These predacious flies work the most serious mischief South, but are not exempt from blame even as far North as Ontario. A parasitic fly of the family Tachinidæ is destructive to bees in several of the States.

In importing bees, the bee louse, *Braula coeca*, has been introduced from Europe; but so far it promises to do little harm in our country.

Amongst Heteroptera, *Phymata erosa* is a dreaded foe of the honey bee. From its close mimicry of the flowers of many composite plants, in which it is wont to hide, it finds it easy to grasp the bees with its unique anterior legs, when it soon sucks out their life juices. *Mantis corolina* kills bees from Central Illinois to the Gulf.

Many of the Libellulidæ, chief among which is *Anax junius*, are so fierce in their onslaught on bees, that they have been termed bee-hawks. These marauders depredate in all sections of our country.

I need not speak, at this time, of the value of bees in fertilizing flowers, as that has been ably discussed by our botanical friends. That bees ever injure buckwheat or other plants, by seeking nectar from their bloom, as is sometimes claimed, is known to be erroneous by all present. That they are equally harmless to grapes and other soft-skinned fruits is not so generally granted. Personally, I have never seen a case, though I have several times gone quite a distance to see them at the request of positive individuals. In each case, the bees were found never to attack sound fruit, but only to sip from such as had burst, or been torn by other insects or by birds. While I am not positive that bees are never guilty of such wrong-doing, I do feel certain that such actions if ever true, is quite exceptional. I have lived in California in the midst of apiaries and vineyards, and I have yet to see the first case of such depravity among bees.

The two great improvements in apiculture since the Langstroth hive, and scientific knowledge gave the apiarist such perfect control over his bees, are the extractor and comb foundation, both of which are recent inventions. In both cases the thought came from Germans, but perfection in carrying it out is due to Yankee genius.

The honey extractor works on the principle of centrifugal force, and by its use honey may be thrown from the combs before it is capped over, or afterward if the cappings be first removed with a knife. By this practice the comb is used over and over again, and as a result, at least twice as much honey can be secured. Experiment proves that it takes at least twenty pounds of honey to secure one of comb, besides the time of secretion is lost, as bees are usually quiet when employed in secreting the wax-scales.

Extracting is often very necessary to furnish room for the queen, so that she may lay eggs. In times of great honey secretion, the workers so fill the cells with honey that the queen finds no place for her eggs, so brood-rearing ceases, and as the workers live only for a few weeks in the active season, depletion of the hive is rapid and sometimes is carried to a fatal extent.

When bees cease gathering, from lack of nectar secretion the queen stops laying, and all brood-rearing ceases. Nothing is found to pay the apiarist so well as to feed sparingly, whenever there is a cessation from gathering honey, and so keep his colonies strong. The extracted honey furnishes a cheap and excellent food for this purpose.

Comb foundation is made from pure bees-wax and is a perfect copy of honey comb, as just commenced by the bees, except that it is much thicker. When given to the bees, they at once accept it, thin it to the usual thickness of natural comb, and use the parings to complete the cells. This saves the time and work of wax secretion and comb building, and secures straight combs, and exclusive worker cells.

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GLACIAL PHENOMENA IN THE YELLOWSTONE PARK.[1]

BY WM. H. HOLMES.

IN common with very many of the more elevated districts of the Rocky mountains, the Park district presents a variety of glacial phenomena. In exploring the deep valleys of the higher ranges, the geologist is never surprised at encountering on all hands partially rounded masses of transparent rock. These are pretty sure to be found on most of the old flood plains of the streams and often high up the sides of the valleys. They are frequently the only remaining records of ancient glaciers which have filled the valleys at different stages of their erosion. The glaciation of rocks *in situ*, in the narrow gorges, also bears testimony to the former existence of glaciers. Loose boulders are doubtless, in many cases, carried from their original beds by the force torrents, and not infrequently reach places very far distant from their original station by a gradual creeping or sliding movement —the result of undermining or yielding of the soil beneath. It is, therefore, far from safe to conclude that wherever erratic rocks are found, glaciers have formerly existed, especially in cases where these rocks may have had their origin in surrounding highlands, or even quite distant mountains of very considerable elevation.

In a region like this, however, there is every reason to suppose that glaciers once existed on a very extensive scale. The park, with the great continental water-shed that surrounds it, forms one of the grandest masses of highland in the United States.

In early quaternary times, as now—if there have been no important changes of level in the meantime—the general level of the park district exceeded eight thousand feet, and the broad areas

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[1] Extracted from the unpublished Report of the U. S. Geol. Survey of the Territories. Exploration of 1878.